Section: Pediatrics

Original Research Article

TO STUDY THE CORRELATION BETWEEN PHYSICAL DIAGNOSIS [CLINICAL EXAMINATIONS / CHEST X-RAY / ELECTROCARDIOGRAM (ECG)] AND ECHOCARDIOGRAPHY DIAGNOSIS IN CONGENITAL HEART DISEASE IN CHILDREN

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Abstract

Background: To Study the Correlation Between Physical Diagnosis [Clinical Examinations / Chest X-ray / Electrocardiogram (ECG)] and Echocardiography Diagnosis in Congenital Heart Disease in Children. **Materials and Methods:** This study was conducted in the Department of Paediatrics at the Rajah Muthiah Medical College and Hospital, from August 2014 to August 2016. The study design is 'Exploratory' in nature, with a proforma been drafted to study patients suspected with features suggestive of congenital heart disease. All patients suspected underwent a thorough clinical examination after a detailed history interview and was followed by investigative work up as per the proforma. The criteria to suspect heart disease CHD was followed as formulated by ALEXANDER NADAS named as NADA's criteria. Specific investigation included Chest X-ray, ECG and Echocardiography. History and Physical Examination revealed a 'provisional clinical impression' and subsequently patient was subjected to ECG and Roentgenographic studies. After this the final diagnosis was assigned and designated termed CLINICAL DIAGNOSIS.2D Transthoracic Echocardiography were obtained and an Echo diagnosis was derived in most cases. **Result:** The Clinico-Echocardiographic correlation in the study showed 96% correlation,3% partial correlation and 1% no correlation. **Conclusion:** Clinical examination, Chest X-ray, ECG have a significant role to play in arriving at a near accurate diagnosis. However, Echocardiographic confirmation of diagnosis.

INTRODUCTION

The term congenital is derived from the Latin word ('con' means together and 'genitus' means born) referring to 'present at birth'. Congenital heart disease (CHD) is defined as an abnormality in 'cardiocirculatory' structure or function that is present since birth, even though it may be discovered later.[1]

CHD remains the leading cause of death in children with malformation.[2] Incidence being 8 CHD's per 1000 live births and is the most common congenital abnormality.

Today we have come a long way and in a very fortunate way than were our early twentieth century colleagues in that their statements of 'wisdom' then may seem to be 'ridiculous' today.

With the currently available treatment modalities over 75% of infants born with critical heart disease can survive beyond the first year of life and many can lead a near normal life thereafter.

Never before did so much significance was attached to an early establishment of the disease than is now because with newer treatment modalities becoming available, hence making it all the more important to establish an early diagnosis to significantly decrease the morbidity and mortality (associated with CHD). Moreover, CHD's serve as pointers of relatively unnoticed syndromes since associated non- cardiac malformations of identifiable syndromes is noted in as many as 25% of CHD's.[2]

The clinical profile of CHD needs to be thoroughly studied and analyzed to facilitate early detection and diagnosis, later to be confirmed by echocardiography and to deliver the appropriate management at the right time. It would also allow the physician to identify relatively unnoticed syndromes and act swiftly to do the needful.

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Physical diagnosis consists of synthesis of information from FIVE sources: Physical appearance, arterial pulse, JVP, precordial examination and auscultation.[3] With newer diagnostic modalities including echocardiography, it is now considered as 'near confirmatory' in diagnosing most of the congenital heart lesions.[1]

In developing countries like India alongside studying the clinical profile it may be worthwhile to study the socio-economic variables / demography and correlate with the disease, which may have bearing on the disease presentation, severity, prognosis and treatment modality / affordability.

It needs to be ascertained as to what would be the diagnostic reliability of clinical diagnosis versus Echocardiography diagnosis.

MATERIALS AND METHODS

This study was conducted in the Department of Paediatrics at the Rajah Muthiah Medical College and Hospital, from August 2014 to August 2016. The hospital is a major referral center (Tertiary Teaching Hospital) in the region. Seventy-Five patients from the defined age groups in both sexes were studied during the study period. The study design is 'exploratory' in nature, with a proforma been drafted to study patients suspected with features suggestive of congenital heart disease. All patients suspected underwent a thorough clinical examination after a detailed history interview and was followed by investigative work up was as per the proforma.

The criteria to suspect heart disease CHD was followed as formulated by Alexander Nadas named as NADA's criteria.

Major	Minor
• Systolic murmur III or more especially with thrill	• Systolic murmur less than III
• Diastolic murmur	• Abnormal S2
• Cyanosis	• Abnormal ECG
• CCF	• Abnormal X-ray
	• Abnormal BP

One major / 2 minor criteria are essential for diagnosis of heart disease.

Following features further help identify CHD

a. Murmurs of obstructive and regurgitant lesions should be audible immediately at birth whereas murmurs of left to right shunt tend to appear later.
b. Murmur presenting within the first year of life is a strong pointer towards a congenital lesion.
c. Murmurs of congenital lesion tend to be parasternal rather than apical.

Inclusion criteria

Features suggestive of CHD in the age group of children 1 month to 12 years.

Exclusion criteria

- 0 month
- Age greater than 12 years
- Features not suggestive of CHD
- Innocent murmurs (functional)

Investigations

- Routine investigations like Hb%, TC, DC, ESR.
- Urine routine (Sugar, albumin, microscopy)
- Specific investigation like – Chest X-ray, ECG, Echocardiography.

All procedures and interventions have been established only after obtaining adequate and appropriate consent in a prescribed form. Ethical clearance has been obtained from the Ethical clearance committee chaired by the Dean Medical College, RMMCH, in a prescribed certificate. Upon enrollment in the study on written consent was obtained and duly signed by the parents in a prescribed format.

After inclusion in the study in each case a thorough history was taken followed by a detailed examination and the observations were recorded in a prescribed proforma (Annexure).

History and Physical Examination revealed a 'provisional clinical impression' and subsequently patient was subjected to routine test, ECG and roentgenographic studies. After this the final diagnosis was assigned and designated termed CLINICAL DIAGNOSIS.

2D transthoracic echocardiography were obtained and an echo diagnosis was derived in most cases.

RESULTS

7685 cases were admitted during the study period to Rajah Muthiah Medical College, Annamalai Nagar, Chidambaram, in children less than 12 years. A total of 82 cases were diagnosed to be CHD during the period. The 82 cases diagnosed are included for the study. Total Hospital Incidence of CHD in our Study

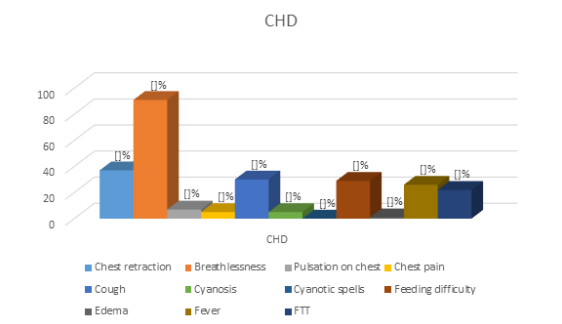

Figure 1: Modes of Presentation of CHD (over all)

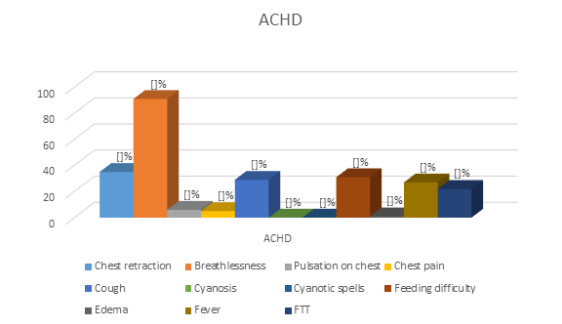

Figure 2: Modes of Presentation of ACHD

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Table 1: Hospital incidence of CHD

Total No. of Admissions (during study period)	7685
No. of cases of CHD (during study period)	82
Percentage of CHD	1.06

Among the 7685 cases admitted 82 were found to be suffering from CHD resulting in a hospital incidence of 1.06%.

Distribution of CHD by Age Group in our Study

Table 2: Distribution of CHD by Age Group

CHD Type	Age Group					
	0-28 Days	28 Days -1 Year	1-3 Years	3-5 Years	5-8 Years	8-12 Years
ASD+VSD	2	1	0	0	0	0
ASD+PDA	3	1	0	0	0	0
PDA+VSD	1	1	0	0	0	0
ASD	23	7	1	1	0	0
VSD	10	11	3	2	1	1
PDA	3	4	1	0	0	1
CCHD	0	1	1	1	1	0
%	51	31	7	5	3	3

82 cases were sorted in 6 class intervals. That constitute neonatal period, under 1 year, under 3 years, under 5 years, under 8 years and under 12 years. The youngest case in study was 4 days and eldest was 12 years. Neonatal cases constitute 51%, under 1 year constitute 31%, under 3 years constitute 7%, under 5 years constitute 5%, under 8 years constitute 3% and under 12 years constitute 3% of total cases respectively.

Distribution of CHD by Sex in our Study

Table 3: Distribution of CHD by Sex Ratio

CHD Type	SEX	
	Male	Female
ASD+VSD	1	2
ASD+PDA	2	2
PDA+VSD	1	1
ASD	15	17
VSD	14	14
PDA	2	7
CCHD	3	1
%	46	54

The distribution of CHD in males and females remains more or less equal with male contributing 46% and females 54%.

Distribution of CHD by Modes of Presentation in our Study

Table 4: CHD and Common Symptoms based on frequency

CHD Type	Common Symptoms (Frequency)											
	Chest retraction	Breathlessness	Pulsation on chest	Chest pain	Cough	Cyanosis	Cyanotic spells	Feeding difficulty	Edema	Fever	FTT	Total
ASD+VSD	2	3	0	0	1	0	0	3	0	0	0	3
ASD+PDA	1	4	0	0	0	0	0	2	0	1	1	4
PDA+VSD	0	2	0	0	0	0	0	0	0	0	1	2
ASD	6	29	0	0	7	0	0	3	0	3	2	32
VSD	13	25	4	3	12	0	0	11	0	14	9	28
PDA	5	8	1	1	3	0	0	5	1	3	4	9
CCHD	3	4	1	0	2	4	0	0	0	0	1	4

Table 5: CHD and Common Symptoms based on frequency

CHD Type	Common Symptoms (Frequency)											
	Chest retraction	Breathlessness	Pulsation on chest	Chest pain	Cough	Cyanosis	Cyanotic spells	Feeding difficulty	Edema	Fever	FTT	Total
ACHD	27	71	5	4	23	0	0	24	1	21	17	78
CCHD	3	4	1	0	2	4	0	0	0	0	1	4
CHD	30	75	6	4	25	4	0	24	1	21	18	82

Table 6: CHD and Common Symptoms by percentage

CHD Type	Common Symptoms (Percentage - %)										
	Chest retraction	Breathlessness	Pulsation on chest	Chest pain	Cough	Cyanosis	Cyanotic spells	Feeding difficulty	Edema	Fever	FTT
ASD+VSD	67	100	0	0	33	0	0	100	0	0	0
ASD+PDA	25	100	0	0	0	0	0	50	0	25	25

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PDA+VSD	0	100	0	0	0	0	0	0	0	0	50
ASD	19	91	0	0	22	0	0	9	0	9	6
VSD	46	89	14	11	43	0	0	39	0	50	32
PDA	56	89	11	11	33	0	0	56	11	33	44
CCHD	75	100	25	0	50	100	0	0	0	0	25

Table 7: CHD and Common Symptoms by percentage

CHD Type	Common Symptoms (Percentage - %)										
	Chest retraction	Breathlessness	Pulsation on chest	Chest pain	Cough	Cyanosis	Cyanotic spells	Feeding difficulty	Edema	Fever	FTT
ACHD	35	91	6	5	29	0	0	31	1	27	22
CCHD	75	100	25	0	50	100	0	0	0	0	25
CHD	37	91	7	5	30	5	0	29	1	26	22

Chest retraction and breathlessness (easy fatigability) are the first two ranks in symptoms in CHD. Cyanosis, feeding difficulty, fever and FTT are the other common symptoms which constitute 20-30%.

Chest retraction, Breathlessness, FTT, feeding difficulty, fever and cough are the common symptoms amongst ACHD. In case of CCHD cyanosis, breathlessness, chest retraction is the first three 'ranks' symptoms, cyanosis seen in 100% of CCHD cases. So for CCHD cyanosis have significant association with CCHD.

Distribution of CHD by Past Symptomology in our Study

Table 8: Distribution of CHD by Past Symptomology

CHD Type	RRTI	CCF
ASD+VSD	0	0
ASD+PDA	0	0
PDA+VSD	0	0
ASD	12	0
VSD	7	1
PDA	5	1
CCHD	0	0
Total	24	2
%	29	2

Among the past history recurrent respiratory tract infection was found in 29% and CCF only 2% of the total CHD cases.

Distribution of CHD by Murmur in our Study

Table 9: Distribution of CHD by Murmur

CHD Type	Murmur			
	PSM	LSM	CM	ESM
ASD+VSD	2	1	0	0
ASD+PDA	0	1	2	1
PDA+VSD	2	0	0	0
ASD	0	1	0	31
VSD	19	8	0	1
PDA	1	0	8	0
CCHD	0	0	0	4
Total	24	11	10	37
%	29	13	12	45

Most commonly occurring murmur in CHD was found to be ESM and next PSM, LSM and continuous murmur (CM) followed notably no diastolic murmur was found. These associations were found to be statistically very significant.

Among ASD and VSD cases more than 40% is with ESM and more than 15% with PSM. Among PDA cases 90% is with CM and 100% of the CCHD cases are with ESM.

Distribution of CHD by XRAY in our Study

Table 10: Distribution of CHD by XRAY

CHD Type	XRAY				
	CDM	PLETHORA	OLIGEMIA	CDM + PLETHORA	Normal
ASD+VSD	2	0	0	1	0
ASD+PDA	2	0	0	0	1
PDA+VSD	1	0	0	0	1
ASD	7	1	1	1	23
VSD	18	0	0	2	8
PDA	7	0	0	2	0
CCHD	0	0	4	0	0
Total	37	1	5	6	33
%	45	2	6	7	40

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Among the 82 cases included in study 45% of them showed CDM and 40% found to be normal. Oligemia, Plethora contributes less than 10% of the cases.
Distribution of CHD by ECG in our Study

Table 11: Distribution of CHD by ECG

CHD Type	ECG				
	LVH	RVH	BVH	Normal	STRAIN PATTERNS (rsr`)
ASD+VSD	1	0	1	1	0
ASD+PDA	0	0	1	3	0
PDA+VSD	2	0	0	0	0
ASD	0	5	0	23	4
VSD	6	2	1	19	0
PDA	7	0	0	2	0
CCHD	0	4	0	0	0
Total	16	11	3	48	4
%	19	13	4	59	5

Most prevalent ECG finding among all CHD's was LVH (19%), followed by RVH (13%). In summary 41% of all CHD's had an abnormal ECG finding and this was found to be statistically very significant.

Distribution of CHD by Echo Finding in our Study

Table 12: Distribution of CHD by Echo Finding

CHD Type	SUB-TYPE	ECHO - FREQUENCY	%
ASD+VSD	-	2	2
	OS	1	1
ASD+PDA	-	3	4
	OS	1	1
PDA+VSD		2	2
ASD	PFO	11	13
	OS	21	26
	OP	0	0
	SV	0	0
VSD	PERIMEMBRANEOUS + MUSCULAR	19	23
	PERIMEMBRANEOUS	7	9
	INFUNDIBULAR	0	0
	INLET/AV CANAL	0	0
	MUSCULAR	2	2
PDA		9	11
CCHD		4	6

In Echo findings of the total CHD cases, OS contributes for 28% and PFO contribute for 13% in ASD type. Perimembraneous and muscular types dominates in VSD with more than 23%.

Clinico-Echocardiographic correlation in our Study

Table 13: Clinico-Echocardiographic Correlation

Correlation	No of cases	Percent (%)
Correlated	76	93
Partially correlated	5	6
Not correlated	1	1

Table 14: Clinical Presentation in various studies

Symptoms	Padedum Venkata Raghavaivh et al	Sandeep et al	Present study
Breathlessness	35.1%	88%	91%
Chest retractions	57.4%	40%	37%
Cyanosis	11.1%	26%	5%
Cough	53.7%	35%	30%
Feeding difficulty	14.8%	25%	29%
FTT	25.9%	40%	22%
Fever	24%	24%	26%

Table 15: Clinico-Echocardiographic Correlation

	No of cases	Percent (%)
Correlated	76	93
Partially correlated	5	6
Not correlated	1	1

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DISCUSSION

Congenital Heart Disease comprises one of the major diseases in pediatric age group and is one of the leading cause of death in children. The incidence of CHD in the general population is 5-8 of 1000 live births. The incidence is higher in stillborn (3-4%), spontaneous aborted (10-25%) and premature infants (about 2 % excluding PDA)

Seven thousand six hundred eighty-five children (< 12 yrs.) were admitted during the study period, of whom 82 cases were diagnosed with congenital heart disease.

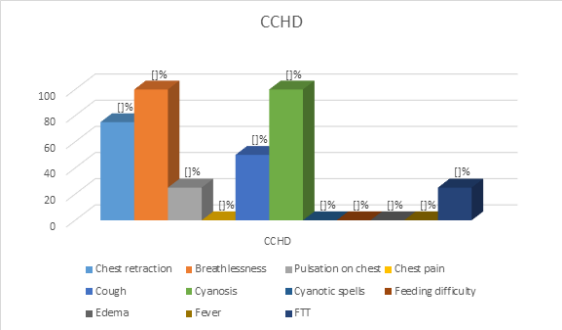

Figure 3: Modes of Presentation of CCHD

The patients were studied for clinical profile and Echocardiographic features as defined by the objective of the study.

In the present series, our hospital incidence rate 1%. However it is contradicting to high prevalence of CHD reported from other places in India. This is comparable with other studies by Bhat NK et al (8.5%), Bhardwaj et al (19.14%) and Sawant SP et al20 (13.28%). The lower incidence might be because of scatter of referrals to other cardiac center's located nearby to our hospital.[4-6]

Among the major CHD groups studied, 95% were ACHD and 5% were CCHD, which is congruent with other studies conducted by Bhushan et all had similar results with 67.5% were ACHD and 32.5% were CCHD. A retrospective analysis of 877 cases admitted in a hospital in Delhi, Khurshid Wanni et all had results comprising 88.5% ACHD and 11.5% CCHD.[7-9]

Relative frequency of various CHD's was studied and deducted the most common CHD in our study were ASD similar to some studies conducted by Kantakumar et al in a tertiary care teaching hospital in Southern India and is contradictory to other studies were VSD were common.

Khurshid Wanni et31all found VSD as common ACHD comprising 76% in the age group between 1-12 months. As this a hospital-based study most ASD, which are asymptomatic, might not had presented to hospital. In our study, most ASD were diagnosed incidentally, when evaluated for other conditions presented with similar symptoms of CHD's. Isolated PDA were observed as 11%.

Age Distribution

CHD's were sorted by different age groups. That constitute neonatal period, under 1 year, under 3 years, under 5 years, under 8 years and under 12 years. The youngest case in study was 4 days and eldest was 12 years. Majority constitute the Neonatal cases 51%, under 1 year constitute 31%, under 3 years constitute 7%, under 5 years constitute 5%, under 8 years constitute 3% and under 12 years constitute 3% of total cases respectively. A study conducted by Kantakumari et al the maximum frequency during the infancy period reported were 29.16%. Among non-infants under five were found to be 20.83%. Ritu Bhardwaj et al in a study detected 33% CHD under 1 year and 25% under 5 yrs of age. A study by Bhusahn Deo et al conducted study in north India were congruent with our study results, with neonates constituted the largest group of 50%, during infancy 15% and under 5 were 21.67%. Kantakumari et al reported 34.5% in infancy and 21.2 % under 5 yrs. In a study done by Padedam Venkata Raghavaiah et al infancy constituted 40.7% and under five were 46.3%.[10-12]

This discrepancy can be explained, as in some studies the newborns were not included. This is evidenced by the fact that the present study matched the study by Bhushan Deo et al7 in the age group of neonates.

Sex Distribution

The male female ratio in present study is 1:1.72 which is similar to the study done by Kantakumari et al where female outnumbered male with male female ratio as 1:1.2.This is contradictory to various study with male preponderance conducted by Bhusahn Deo et al were 1.45:1 and Padedam Venkata Raghavaiah et al were 1.57:1. In CHD the cases are equally affected, though in individual cases there may be preponderance of one over the other. Nearly equal Male female ratio seen in few studies when screened by physicians at birth. In our present study, ASD and PDA were more observed in females and VSD observed equally in both the sexes.[13,14]

Clinical presentation

The modes of presentation Of CHD seen in our study includes most frequently breathlessness (91%) followed by chest retractions (37%), cough (30%), feeding difficulties (29%), failure to thrive (22%) and edema (1%).

Breathlessness/easy fatigability (91%), chest retractions (35%), feeding difficulties (31%) were first three symptom 'ranks' among ACHD. In case of CCHD cyanosis (100%), breathlessness (100%), chest retractions (35%) were the first three 'ranks' symptoms.

Statistically presence of cyanosis as a mode of presentation is significant in case of CCHD and its absence is significant in case of ACHD. Padedam et al deduced the symptomology in CHD and found chest retractions to be found in 57.4% in all CHD's followed by symptoms of cough (53.7%), breathlessness (35.1%), FTT (25.9%), Fever (24%),

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feeding difficulties (14.8%),cyanosis (11.1%), edema (9.2%) and cyanotic spell (3.7%). In a study conducted by Sandeep at al, the common presentations in CHD were breathlessness (78%), LRTI (60%), FTT (40%), cyanosis (26%), fever (24%) and asymptomatic (6%).

In our present series, past symptomology of recurrent respiratory tract infections were found in 29% of CHD. The increased frequency of respiratory tract infections in ACHD is explained by increased flow to pulmonary tree. And CCF were observed in 2 % of cases. Sandeep et al found CCF in 56%.

In our study, the most common murmur was Ejection systolic murmur (48%) followed by Long systolic murmur (30%), Pan Systolic murmur (12%) and continuous murmur (10%).

The most common murmur in ASD were ESM usually in the second, third intercostals space on left due to increased flow across the pulmonary valve. The PSM found in VSD heard in left lower sternal border.

CXR

We studied 82 cases and found chest X-ray abnormal in 60% of the cases and the most common observed abnormality were Cardiomegaly (45%), 7% cardiomagaly had plethors predominantly observed in ASD, VSD, PDA. Normal cardiac size and oligemia were seen in 6% of cases, majority were TOF.

Although chest X-ray alone cannot be taken as diagnostic proof it helps a great extent in making a clinical diagnosis. When the cardiomegaly is of mild to moderate severity it may be possible to decide that the shape is that of right or left ventricular hypertrophy. With a very large cardiac shadow the distinction between right and left ventricular enlargement may be lost. Right ventricular hypertrophy tends to give a smaller arc of cardiac apex which appears above the left hemidiaphragm as upturned apex. On the other hand left ventricular hypertrophy gives the appearance of broader apex, which tends to dip below the left hemidiaphragm. Cardiomegaly usually indicates either a large shunt, valvular regurgitation or failing ventricle. Prominence of the main pulmonary artery segment is seen in left to right shunts, valvular pulmonic stenosis and pulmonary arterial hypertension. The main pulmonary artery segment is relatively larger in ASD compared to VSD or PDA. In a cyanotic variety it was possible to decide whether there was increased pulmonary flow or decreased pulmonary flow. Characteristic silhouette were boot shaped in TOF.

Electrocardiogram

Of all 82 cases studied, ECG abnormality deducted in 41% of cases. The most common abnormality were LVH (19%) followed by RVH (13%), rsr' pattern (5%) and CVH noted in 4%. 59% of cases, ECG were found to be unremarkable.

For bedside diagnosis of congenital heart disease the ECG provides invaluable help. The features which were useful in helping diagnosis consist of atrial enlargement and ventricular hypertrophy and conduction disturbances in pediatric age group were relatively quite common.

Clinico-Echocardiographic Correlation

Clinical diagnosis is essential and forms the backbone of pediatric cardiology where clinical acumen of physicians have to be sharper than their more fortunate peers abroad. 'Clinical diagnosis' encompasses history, physical examination, roentgenography and electrocardiogram in this study. Echocardiography confirmed the diagnosis.

We were accurate in the diagnosis in 93 % (76 cases), especially when dealing with isolated lesions, and were partially correct in 6% cases, which were multiple lesions.

The clinical diagnosis made in this study and correlated Echocardiographic diagnosis percentage is comparable with other studies.

Padedum et al, in their study observed clinic-echocardiographic correlation up to 68.5%. Dipendra Sharma et al studied the clinic-echocardiograghic correlation in a tertiary care hospital in Kota and were able to clock 62.6% accuracy.

The increasing dependence of newer cardiologist on non-invasive technique is imperative.

Observation in present study were Mortality rate of 2.44% which were diagnosed as complex CHD, due to CCF. Compared to study by Sandeep et al were the mortality rate is 18%.

CONCLUSION

- Infancy is the most common age of presentation of CHD
- Females outnumbered males in the CHD cases
- Most common presenting symptoms in CHD was chest retraction, breathlessness.
- Nearly 2% of the CHD cases present in RRTI and CCF
- About a third of all CHDs had history of recurrent respiratory tract infection (RRTI).
- Most common murmur on auscultation in CHDs were ESM and LSM / PSM.
- Chest X-ray is an important corroborative evidence in the diagnosis of CHD and was abnormal in 60% of cases.
- ECG is another important invaluable tool and was abnormal in 40% of cases, majority of whom had left axis deviation / left ventricular hypertrophy.
- All of cases diagnosed clinically were within the 'common eight' CHDs (ASD, VSD, PDA, AS, PS, CoA, TOF, TGA). Most common clinically diagnosed CHD was ASD.
- Properly carried out clinical examination, X-ray and ECG evaluation are important tools in arriving at a near accurate diagnosis in CHD, however before undertaking surgical

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intervention echocardiographic confirmation of diagnosis is required.

- Until sophisticated diagnostic tools are widely available in developing countries, thorough clinical examination, chest X-ray, ECG have a significant role to play in arriving at a near accurate diagnosis.

In a condition like CHD with a prevalence of 8/1000 live births a sample size of 82 random cases presenting to a hospital have its own limitations. The conclusions drawn and interpretations made need to be read in the light of this fact and may require confirmation by larger community based studies.

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